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WARP BOUND COMPOSITE PAPERMAKING FABRIC**Background of the Invention**

The present invention is directed to a composite papermaking fabric which is preferably used in the forming section but could also be used in the dryer section. The term composite fabric refers to a fabric comprising two woven structures one of which is the paper side fabric or upper fabric and the other of which is the machine side fabric or lower fabric. The paper side fabric includes a support surface which surface receives and supports the paper forming pulp during the paper forming operation. The lower or contact fabric separates the support fabric from the machine rollers during the paper forming operation and includes a roller contact or contact surface. Both fabrics must be stable and provide the required drainage. The support fabric must also provide an even support surface without unduly high knuckles or unduly deep knuckle depressions so as to not mark the paper during the paper forming operation.

The upper and lower fabrics are bound together with a binder yarn which in the instant case comprises fabric born warp yarn. The term fabric born warp yarn indicates that the binder yarn while binding the upper and lower fabrics together also weaves in the machine direction with and is an integral part of the weave pattern of both the upper and lower fabrics. The term warp yarn refers to yarns which weave in a single specified layer of the fabric and in the machine direction. The term weft yarn refers to yarns woven transverse of the warp yarns.

Composite papermaking fabrics are well known as are illustrated by the U.S.

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5 Patents 5,152,326; 5,828,627; 6,202,705; and 6,240,973.

It is an object of the present invention to provide a composite papermaking fabric which provides uniform drainage, a smooth and even support surface and extended wear.

Another object of the invention is a papermaking fabric in which the support
10 surface is formed in a one up, one down weave pattern.

Another object of the invention is a composite papermaking fabric in which fabric born warp yarns bind the upper and lower fabrics together and weave with weft yarns to form the lower fabric.

Another object of the invention is a composite papermaking fabric in which the
15 weft yarn of the upper fabric at the binding points are supported against downward movement.

Another object of the invention is the provision of a composite papermaking fabric in which no pairing of weft yarns appear on either surface.

Another object of the invention is the provision of a composite papermaking
20 fabric in which no pairing of warp and fabric born warp yarns appear on either surface.

Summary of the Invention

The present invention is directed to a composite papermaking fabric having an
25 upper fabric which includes a fiber support surface and is formed of warp yarns, fabric born warp yarns and weft yarns. The support surface is woven in a one up, one down

5 weave pattern. The papermaking fabric also includes a lower fabric formed of fabric born warp yarns and weft yarns interwoven to provide a weft yarn dominated contact surface. Each fabric born warp yarn is controlled to weave over at least one of the upper fabric weft yarns during each repeat of the weave pattern forming binding points which act to bind the upper fabric with the lower fabric.

10 The preferred weave pattern requires that each fabric born warp yarn weave over two of the upper weft yarns to form two binding points which are spaced longitudinally of the weave pattern. The binding points preferably form a broken twill line across the weave pattern and the width of the papermaking fabric. But it is also possible that the binding points form a straight twill line across the paperside weave pattern.

15 To insure that the support surface is even and smooth, the upper warp yarns float beneath the upper weft yarns at each of the binding points forming a support beneath the upper weft yarns which acts to maintain knuckle height uniform across the support surface. The fabric born warp yarns weave with the weft yarns of the lower fabric in preferably a broken twill pattern forming a plurality of even weft floats on the contact surface. There is a plurality of the weft yarn floats formed by each lower weft yarn per weave pattern repeat.

20 A composite papermaking fabric comprising an upper fabric formed with a support surface woven in a one up, one down weave pattern and a lower fabric formed with a weft dominated contact surface. The papermaking fabric comprises a plurality

- 5 of warp yams weaving with upper weft yams in a selected first weave pattern and a plurality of fabric born warp yams weaving with lower weft yams in a selected second weave pattern forming the lower fabric and weaving with the upper weft yams in the second selected weave pattern to cross over the upper weft yams at selected locations forming binding knuckles. The fabric born warp yams at the binding knuckles bind the
- 10 upper fabric with the lower fabric. The binding knuckles cooperate with the knuckles of the warp yams weaving in the first weave pattern to form the support surface in a one up, one down weave pattern.

The warp yams weave beneath each of the upper weft yam at the selected locations forming the binding knuckles providing support beneath the upper weft yam and the binding knuckle which support assists in maintaining the binding knuckles parallel with the remainder of the knuckles of the support surface.

The weft yam weaving with the fabric born warp yams form the contact surface with two floats on the contact surface per pick throughout a weave pattern repeat.

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Drawings

Fig 1 is a cutaway perspective view showing the support surface of the papermaking fabric through a portion of the weave pattern.

Fig 2 is a cutaway perspective view showing the contact surface of the papermaking fabric through a portion of the weave pattern.

5 **Fig 3 is a side view showing the relationship of warp yarn 1 and fabric born warp
yarn 2 with all of the weft yarns through the weave pattern.**

Fig 4 is similar to Fig 3 showing the relationship of warp yarn 3 and fabric born
warp yarn 4 with the weft yarns through the weave pattern.

Fig 5 is similar to Fig 3 showing the relationship of warp yarn 5 and fabric born
10 warp yarn 6 with the weft yarns through the weave pattern.

Fig 6 is similar to Fig 3 showing the relationship of warp yarn 7 and fabric born
warp yarn 8 with the weft yarns through the weave pattern.

Fig 7 is similar to Fig 3 showing the relationship of warp yarn 9 and fabric born
warp yarn 10 with the weft yarns through the weave pattern.

15 Fig 8 is similar to Fig 3 showing the relationship of warp yarn 11 and fabric born
warp yarn 12 with the weft yarns through the weave pattern.

Fig 9 is similar to Fig 3 showing the relationship of warp yarn 13 and fabric born
warp yarn 14 with the weft yarns through the weave pattern.

Fig 10 is similar to Fig 3 showing the relationship of warp yarn 15 and fabric
20 born warp yarn 16 with the weft yarns through the weave pattern.

Fig 11 is a diagram of the weave pattern of the support surface.

Fig 12 is a diagram of the weave pattern of the contact surface.

Detailed Description

5 Turning now to the drawings Figs 1 and 2 represent sectional perspective views
of the composite papermaking in which the upper fabric A is formed with a paper pulp
support surface C as shown in Fig 1 and the lower contact fabric B which is formed with
a lower roller contact surface D as shown in Fig 2. As shown in Fig 1 and further
illustrated in Fig 11, upper fabric A and more specifically, support surface C is woven
10 in a one up, one down weave pattern allowing the support surface to present an even
array of warp knuckles separated on each side by a weft knuckle. This is best
illustrated in Fig 11 where each O represents a warp yarn passing over a weft yarn on
the support surface. Each passover forms a warp knuckle. Likewise, each weft yarn
passing over a warp yarn on the support surface is represented by a blank square.
15 These passovers form weft knuckles. Each O represents a binding point where the
warp yarn passing over the weft yarn is an fabric born warp yarn.

 The fabric is woven utilizing eight warp yarns numbered 1, 3, 5, 7, 9, 11, 13 &
15 17 and with eight fabric born warp yarns numbered 2, 4, 6, 8, 10, 12 & 16 per weave
pattern repeat which is a so called 16 shaft weave. The present invention is not limited
20 to the weave repeat shown in the figures. It's understood that the weave repeat in
general can be 16 shaft or greater. Therefore the weave repeat could be for example
a 20 shaft or a 24 shaft or a 28 shaft or a 32 shaft or a 40 shaft weave. The weave
pattern repeat also weaves with forty weft yarns numbered 1-40. Weft yarns 2, 3, 5,
25 7, 8, 10, 11, 12, 13, 15, 17, 18, 20, 22, 23, 25, 27, 28, 30, 32, 33, 35, 37, 38 & 40
weave with the warp yarns and the fabric born warp yarns to form the upper or support

5 fabric A. Weft yarns 1, 4, 6, 9, 11, 14, 16, 19, 21, 24, 26, 29, 31, 34, 36 & 39 weave
only with the fabric born warp yarn to form lower or contact fabric B.

Again turning to Figs 1, 2, 11 & 12. In Figs 1 & 11, the x represents the binding points or the positions in which an fabric born warp yarn passes over an upper weft
yarn weaving with the support fabric A to bind the support fabric A with the contact
10 fabric B forming the composite fabric. These binding points, which form binding
knuckles 70, are identified in Figs 1 and 3-10.

Figs 3-10 are side views of each of the warp and fabric born warp yarns
weaving with the weft yarns 1-40 through a complete repeat of the weave pattern. As
can be seen in Figs 3 - 10 the ratio of upper weft yarns to lower weft yarns is 3 : 2. It
15 is understood that this ratio is not limiting the scope of the invention, therefore the ratio
exemplary also could be 2 : 1 or 5 : 3. As is clearly shown, warp yarns 1, 3, 5, 7, 9, 11,
13 & 15 weave only with weft yarns 2, 3, 5, 7, 8, 10, 12, 13, 15, 17, 18, 20, 22, 23, 25,
27, 28, 30, 32, 33, 35, 37, 38 & 40 forming support fabric A. The weave pattern at
selected points brings the upper warp yarns to float beneath five consecutive of the
20 upper weft yarn picks, such as warp yarn 1 at the pick of weft yarns 15, 17, 18, 20 &
22 in Fig 3 and warp yarn 5 at the pick of weft yarns 5, 7, 8, 10 and 12 in Fig 5. It is
along these floats that the fabric born warp yarns are brought up to pass over two
spaced picks, such as fabric born warp yarn 2 over picks 17 & 20 in Fig 3 and fabric
born warp yarn 6 over picks 7 and 10 in Fig 5, binding upper fabric A with lower fabric
25 B. Throughout the remainder of the weave pattern, each of the fabric born warp yarns

5 weaves with selected of the upper weft yarns securing support fabric A with contact fabric B at the binding points illustrated in Fig 11 along each fabric born warp yarn. The binding points form a broken twill pattern over the support surface. It has to be stated that the weave pattern of the support fabric A predominantly is created by the weaving of the warp yarns 1, 3, 5, 7, ... with the upper (paper side) weft yarns 2, 3, 5, 10 7, 8, 10, 11, 12, 13, 15, 17, 18, 20, 22, 23, 25, 27, 28, 30, 32, 33, 35, 37, 38 & 40 and that the weaving of the fabric born warp yarns 2, 4, 6, 8, 10, 12 & 16 with the (paper side) weft yarns gives a minor contribution to the weave pattern of the support fabric A. It can be stated that for the composite papermaking fabric according to the invention the warp yarns weave during each repeat of said weave pattern with a predominant or 15 major portion of the upper weft yarns and that the fabric born warp yarns weave only with a minor portion of the upper weft yarns to form the upper fabric weave pattern. It is to be understood that a major portion means a portion of more than 50% and a minor portion means a portion of less than 50%.

20 By way of example as can be seen in Fig 3 warp yarn 1 weaves with upper (paper side) weft yarns 2, 3, 5, 7, 8, 10, 12, 13, 15, 22, 23, 25, 27, 28, 30, 32, 33, 35, 37, 38 & 40 a one up, one down weave pattern and floats beneath the upper (paper side) weft yarns 17, 18, 20. The weave pattern of the support fabric A is completed by the weaving of the fabric born warp yarn 2 with the weft yarns 17, 18, 20.

5 In the weave pattern shown in Fig 3 warp yarn 1 weaves with seven times more
(paper side) wefts than fabric born warp yarn 2.

Again, as seen in Figs 1 & 3-10 at each binding point 70, the associated upper warp yarn passes beneath the pick where the binding point is formed with the fabric born warp yarn. In the above referred to example , warp 1 passes beneath weft yarn or picks 17 & 20 at binding points 70. Likewise in Fig 5 warp yarn or pick 5 passes beneath weft yams 7 & 10 at binding point 70. By so controlling the upper warp yams to be positioned beneath the binding points 70 they function to support the weft yams and thereby the binding knuckles against vertical downward movement. As described previously the weave pattern of the support fabric A predominantly is formed by the weaving of the warp yams 2, 3, 5, 7, 8, 10, 11 ... In advanced studies applicant In general came to the conclusion that for creating a smooth and uniform support surface C it is necessary that the upper (paper side) weft yams which interweave with fabric born warp yams or warp yams and thereby only form a minor portion of the support fabric A need to be supported against vertical downward movement. Therefore, e.g. warp yarn 1 floats beneath (paper side) weft yams 17, 18 & 20. This vertical support acts to help maintain the crest of the knuckles formed at binding points 70 elevated and on an even and substantially parallel plane with the remainder of the knuckles forming the support surface C. Also, by passing the upper warp yams beneath the upper weft at the binding points no adjacent knuckles appear on the support surface at the binding points.

5 Turning now to Figs 2-10 & 12 contact fabric B will now be discussed. As seen
in Figs 2 & 12 contact fabric B is woven in a broken twill pattern with each fabric born
warp yarn passing beneath four weft yams at spaced locations on contact surface D.
Each fabric born warp yam either floats above the lower weft yams and beneath the
warp and weft yams of the upper or support fabric A or passes over the two of the
10 upper picks forming binding points 70 throughout the remainder of each weave pattern
as earlier discussed.

15 Turning again to Figs 2 & 12 it can be seen that the weave pattern forming lower
fabric B produces a weft dominated contact surface D with each weft weaving with the
lower fabric warp yams to form two floats per pick throughout the weave pattern each
of which passes beneath three warp yams. This weave pattern forms a weft yam
dominated running or contact surface D.

20 The yams selected for forming the disclosed may comprise yams of the same
diameter or of varying diameters if desired. For example, it may be desirable to weave
the support fabric with weft yams of less size than the weft yams forming the contact
fabric. The warp and the fabric born warp yams preferably are of the same size.
Variation in yam size may be selected depending upon the performance requirements.

25 The materials chosen for the yams can vary depending upon the performance
needs of the formed papermaking fabric. Generally stability is of the utmost
importance, it being desired that the drainage capability be maintained throughout the
life of the papermaking fabric. Also, wearability is another vital factor due to cost.

5 Accordingly, polyester yarns which exhibit excellent stability characteristics may be selected to form the support surface and as the fabric born warp yarns. The running or contact surface weft yarns may all or partly be polyamide yarns due to greater wearability characteristics. Also, the contact side weft yarns may be of a larger diameter than the support fabric weft yarns. Other synthetic materials and size
10 combinations may be selected to form the warp, weft, and fabric born warp yarns of the invention dependent upon the required performance needs of the fabric.



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